

Paris, October 19th 2020

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To the attention of Beáta Szabó-Takács

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Subject: Offer for a second-hand infrared sky imager Sky InSight™ and software cloud feature licences

Reference number: CO-2020-127-rev1

Dear Ms Szabó-Takács,

Following our discussions, you would like to obtain a revised quotation for a Sky InSight™, Reuniwatt's thermal infrared all-sky camera product, as well as for the associated software cloud feature licences. As you need the instrument to be received on site by 18/12/2020, we suggest to sell you a second-hand instrument which could leave our Toulouse factory as soon as your purchase order is emitted. A new instrument has a lead time of 120 days.

I hope that this offer meets your expectations, and look forward to working with you.

Yours sincerely,

Marion Lafuma

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1 Your needs

Within the Atmospheric Department of CzechGlobe – Global Change Research Institute of the Czech Academy of Sciences – you are doing some research on climate change and the effects of aerosol and clouds on irradiation. For now, you possess a Vaisala ceilometer, but you would like to add another instrument to automatically measure clouds and irradiation.

You need to receive this new instrument by 18/12/2020. Our usual lead time for our Sky InSight™ is 120 days. To be able to deliver the imager on site before the indicated date, please find below our quote for a second-hand instrument which could leave our Toulouse factory as soon as your purchase order is emitted as it is already available there.

2 Presentation of the offer

2.1 Hardware presentation

The Sky InSight™ is a patented system which comprises a long-wavelength infrared camera mounted on an arm to film a hemispherical mirror pointing at the sky, thus providing a 180° sky coverage. A sky temperature map is given under the form of an image, with a resolution of 640*480 pixels. A solar reference cell provides global horizontal irradiance measurements. Temperature and humidity sensors are also integrated under a naturally ventilated shield. A computer is embedded in the housing for data logging.

The housing's dimensions are of 350 mm in diameter and 800 mm in height. The equipment weighs 10 kg. It is designed to be dust-tight and to resist liquid ingress. The hardware is rated IP 65 and operates in the -20 to +60°C temperature range.

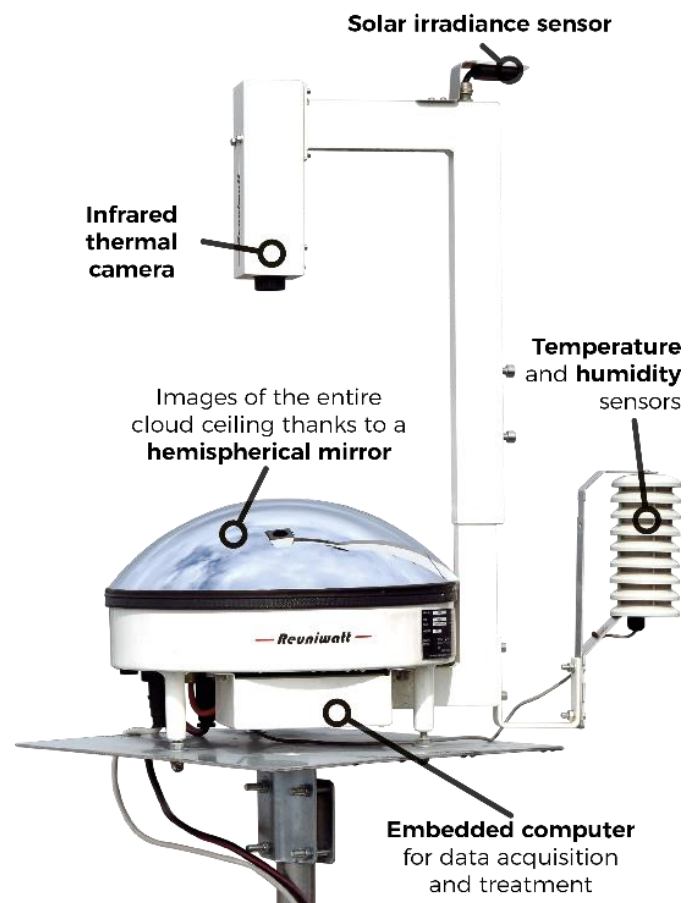


Figure 1 – View of Reuniwatt's Sky InSight™

2.2 Software features

The standard configuration of the Sky InSight™ requires the camera to be connected to the internet. The images are acquired and sent to Reuniwatt’s remote servers where they are processed. The benefits linked to this configuration are the following:

- Easy combination with other Reuniwatt forecasting products such as satellite-image-based forecasts (HourCast™) or numerical weather prediction models (DayCast™).
- Continuous monitoring of image and forecast quality by Reuniwatt’s team.
- Easy storage of the images on the cloud. The images are stored for one month.
- Easy upgrades of the camera features.

Note: a bandwidth of 512 kbps is enough for smooth data transfers.

We offer the following software features (detailed below), calculated in real-time on the images captured by the Sky InSight™:

- *Estimated outputs:* calibrated thermal radiance of the sky (JPEG2000 files), cloud cover estimation (JPEG2000 files), cloud fraction (value between 0 and 1), CBH (in m), cloud classification (probability of occurrence of each class of clouds)
- *Data updates:* once per 30 sec
- *Time stamp:* UTC, compliance to ISO8601
- *Data format:* transmission through Reuniwatt’s API.

2.2.1 Calibrated thermal radiance of the sky

Thermal images are computed thanks to an onboard radiometric calibration over the LWIR spectrum. The thermal images are provided as 16-bit JPEG2000 files.

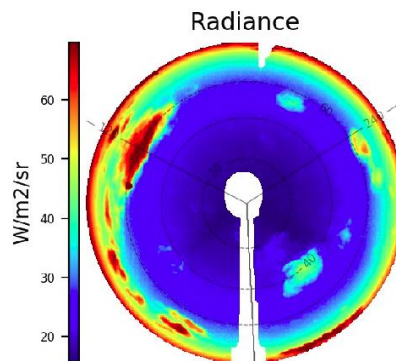


Figure 2 – Example of a radiance image

2.2.2 Cloud cover estimation application

This application processes sky images from the database, estimating the cloud cover for each image. The software computes the cloud cover’s segmented image (the segmentation process is based on temperature thresholding).

The cloud cover images are provided as 16-bit JPEG2000 files.

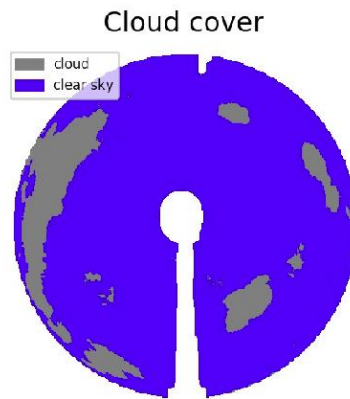


Figure 3 – Example of a cloud cover image

2.2.3 Cloud fraction application

The cloud fraction is estimated from the segmented cloud cover image. The cloud fraction is the solid angle ratio of the cloud compared to the whole sky (value between 0 and 1) for a specific time and location.

The cloud fraction time series are provided as daily CSV (*Comma Separated Values*) files.

2.2.4 Cloud Base Height application (under development – beta version)

Cloud-base height is an information provided using the near zenithal angle. It makes the link between the initial retrieval of sky temperature, and the cloud height that it is related to. The higher the colder, assuming clouds are close to a black body object.

The algorithm has been trained for more than a year using LIDAR reference data from the SIRTa observatory in France, member of ACTRIS European Atmospheric network infrastructure. Thanks to the other embedded sensors, the system will adapt to various climatological zones.

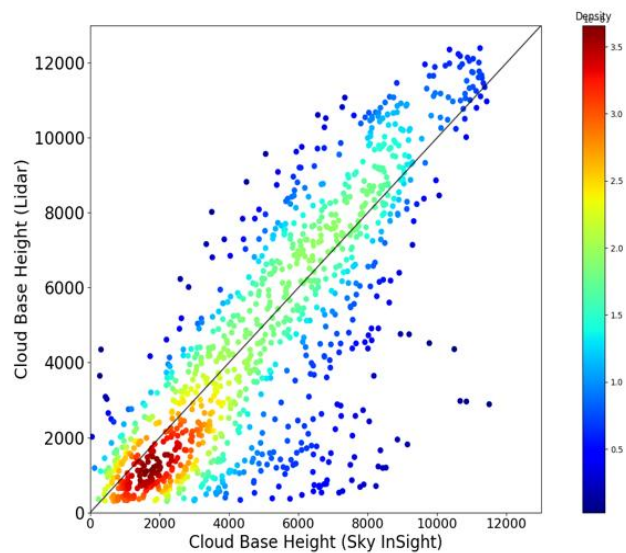


Figure 4 - Cloud-based height retrieved with a Sky InSight™ vs cloud-base height retrieved with a LIDAR

2.2.5 Cloud classification application (under development – beta version)

This application processes sky images from the database, estimating the occurrence of different types of clouds for each image.

The application currently distinguishes five classes in the images: clear sky, cirrus clouds, stratus clouds, cumulus clouds, and nimbus clouds. A ratio of the occurrence of each class is given for the image.

The cloud classification time series are provided as daily CSV (*Comma Separated Values*) files.

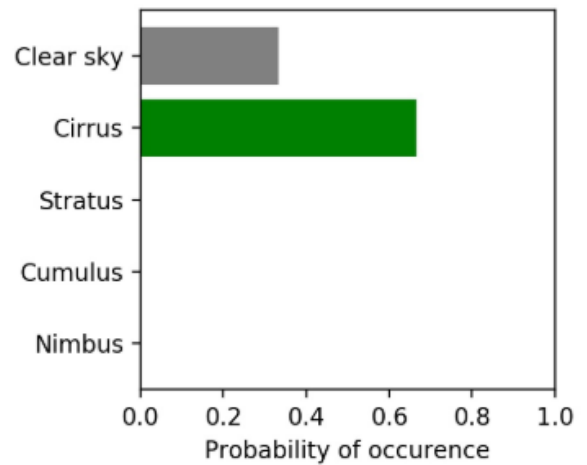


Figure 5 – Example of a cloud classification application

2.3 Option: InstaCast™ forecasting service specification

Reuniwatt’s proprietary forecasting service InstaCast™ can be provided for the project. The indicative specification of the service is the following:

- *Forecasted variable:* Global Horizontal Irradiance GHI [W/m2]
- *Forecast updates:* once per minute
- *Time horizon:* 15 minutes
- *Resolution (time step):* 1 minute
- *Time stamp:* UTC, compliance to ISO8601
- *Data format:* transmission through Reuniwatt’s API in csv format.

3 Price offer

3.1 Hardware supply

Reference	Details	Qty	Price in EUR excl. taxes	Discount	Total price in EUR excl. taxes
Hardware provision and warranty					
Sky InSight™	1-year-old second-hand Sky InSight™: infrared all sky imager <ul style="list-style-type: none"> • ExW provision (Toulouse, France) • 6-month warranty on spare-parts • Installation manual + hotline for installation support (first 5 hours) 	1	58,000 (price of a new equipment)	20% (as it is a 1-year-old second-hand instrument)	46,400
<i>(* Additional 5% discount if Global Change Research Institute CAS publishes at least one article with Reuniwatt in the coming 2 years. The price of the instrument would then be 43,500</i>					
Transportation case	1 all-terrain rigid case for transportation	1	1,150	100%	0
Shipment	Indicative price for DAP Brno (Czech Republic)	1	1,000	-	1,000
Warranty extension	Additional 2-year warranty (total warranty period of 2.5 years): spare parts dispatch & hotline for technical support to local engineers	1	5,000	-	5,000
Total hardware provision			52,400 <i>(* 49,500 (if additional 5% discount is applied)</i>		

Exclusions: structure to support the equipment on site, installation, electrical and numerical connections, commissioning and more generally, all actions not clearly stated in the present document

3.2 Cloud features software supply

Reference	Details	Quantity	Price in EUR excl. taxes
Cloud cover and cloud fraction	<ul style="list-style-type: none"> Software licence for the cloud cover estimation application Software licence for the cloud fraction estimation application 	1	included
Calibrated thermal radiance of the sky	<ul style="list-style-type: none"> Software licence for the calibrated thermal radiance images application 	1	3,000
Cloud classification	<ul style="list-style-type: none"> Software licence for the cloud classification application – beta version 	1	1,000
Cloud base height	<ul style="list-style-type: none"> Software licence for the cloud base height retrieval – beta version 	1	1,000
Total cloud features software supply			5,000

3.3 InstaCast™ forecasting service supply

Reference	Details	Quantity	Price in EUR excl. taxes
Service set-up	InstaCast™ service set-up to be paid only once, at the beginning of the project	1	3,200
Service subscription	<ul style="list-style-type: none"> InstaCast™: intra-hour forecasting service subscription to the forecasting service as described in §2.3 (GHI only) using the Sky InSight™ images as described in §5.3 IT infrastructure maintenance subscription for the cloud post-treatment, continuous improvement of our forecasting methods 	1	5,400 /year
Total for the first year			8,600
Total for the following years			5,400

3.4 Grand total

Reference	Details	Price in EUR excl. taxes
Hardware provision	As detailed in §3.1	52,400 <i>(*) Or 49,500 (if additional 5% discount is applied – see §3.1)</i>
Cloud features software supply	As detailed in §3.2	5,000
InstaCast™ forecasting service supply	As detailed in §3.3	8,600
Grand Total the first year		66,000 <i>(*) Or 63,100 (if additional 5% discount is applied – see §3.1)</i>
Grand Total the following years		5,400

4 Terms and conditions

4.1 Commitment period

Service subscription: The commitment period for regular service subscription is of 1 year, renewable.

4.2 Invoicing terms

Hardware and set up fees: A 50% deposit is invoiced at the order. The balance is invoiced after the delivery of the hardware.

Service subscription: Service delivery is invoiced annually in advance.

Our payment conditions are net 30 days from date of invoice.

4.3 Delivery

For this second-hand instrument, delivery can take place before 18/12/2020 as long as the purchase order is received before 31/10/2020.

The licence and the yearly subscription will begin once the Sky InSight™ is properly installed on site.

4.4 Validity period of the offer

The tariffs aforementioned are valid until the 31st October 2020.

Kind regards,

Reuniwatt
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 SIRET : 518 919 345 00018
 Nicolas SCHMUTZ
 Founder and CEO of Reuniwatt SAS

5 Appendices

5.1 Sky InSight™ datasheet

SOFTWARE	
Data output	
Type	<ul style="list-style-type: none"> Brightness temperature map Cloud-cover image Cloud fraction Compatible with Reuniwatt's InstaCast™ forecasting tool
DATA MANAGEMENT	
Data specification	
Output frequency	Default 30s (adaptable 30s to 5min)
Format	Image: jpeg2000
Data delivery	Several configurations available: <ul style="list-style-type: none"> HTTPs API (json files/images) SFTP (csv files/images) TCP Modbus
Local storage depth	1 month
HARDWARE	
Operating conditions	
Operation	Day and night with identical accuracy
Field of view	360°x180°
Resolution	640x480 pixels
Calibration	Self-calibration from one week irradiance statistics
Environmental conditions	
Temperature range	-20°C to +60°C
IP Rating	IP65
Communications	Ethernet
Power consumption	85W
Voltage	220V/110V AC, 50/60Hz
Dimensions	LxH 350x800mm
Weight	10kg
Ancillary accessories and sensors	
Ancillary sensors	<ul style="list-style-type: none"> Irradiance reference cell (GHI) Temperature and humidity - external probes (optional) Spirit level
Autonomy	Uninterrupted Power Supply (optional)
Remote control	Boot relay Automatic status check

Figure 6 - Sky InSight™ datasheet

5.2 Utilities to be provided by the client

The following utilities are to be prepared by the customer to ensure a proper functioning of the Sky InSight™:

- *Mechanical utility:* The sky imager should be fixed on a flat surface (e.g. a mounting plate), not supplied by Reuniwatt
- *Electrical utility:* The sky imager must be electrically powered via a 230VAC 2A network. A specific waterproof connector is provided, the cable is not provided.
- *Communications:* The sky imager must be connected to the internet for data upload, using an Ethernet cable (not provided). A specific waterproof connector is provided for connecting the camera to the cable (cat.5E minimum) reserved for it.

5.3 InstaCast™ method

Reuniwatt has developed state-of-the-art solar forecasting services. In particular, InstaCast™ is able to exploit images acquired by Sky InSight™. With our physical modelling and machine learning algorithms, we are able to provide irradiance forecasts in the next minutes, according to the method represented below:

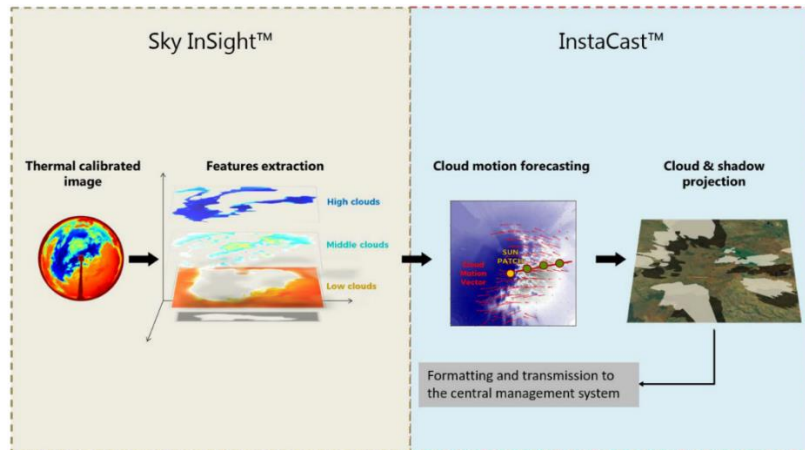


Figure 7 – Presentation of the InstaCast™ method

Reuniwatt can adapt the output of the forecasts, such as:

- **Granularity:** from a forecast every 30 s to one every 5 minutes
- **Forecasting Horizon:** our camera can forecast events from 30 s to 15 minutes in advance

The accuracy of the forecasts strongly depends on the local site’s conditions, and the considered metric for the evaluation.